An ethnoarchaeological perspective on soils

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Introduction

Archaeologists are increasingly recognizing the importance of soils as a variable both in understanding the settlement patterns of prehistoric agriculturalists (e.g. Dennell and Webley 1975; Butzer 1982) and in interpreting the formation processes of archaeological sites (e.g. Birkeland 1984: 344–7; Stein and Farrand 1985; Schiffer 1987: 200–17). As a consequence, there has been an increased emphasis in archaeological research on pedology, or the study of soils in their natural setting. We believe that archaeologists studying prehistoric settlement patterns should also have a working knowledge of *ethnopedology*, or the study of indigenous agriculturalists' knowledge and use of soils.

Pedological studies offer archaeologists answers to questions about the composition and potential uses of different soil types within an archaeological study area. Ethnopedology allows archaeologists to consider a complementary question: 'What could prehistoric agriculturalists, whose sites we study, have known about soils?' While we cannot answer this question directly, it may be informative to examine the variability in soils knowledge of non-Western agriculturalists.

The focus in this discussion will be on societies practising shifting agriculture in the tropics, but the conclusions reached are not necessarily restricted to the tropics. While there has been considerable debate over the appropriateness of models of shifting agriculture for Neolithic societies in temperate zones (e.g. Rowley-Conwy 1981; Bogucki 1988: 81–2), there are at least two good reasons why studies of swidden agriculturalists, and their knowledge of soils, are important to archaeologists working in either temperate or tropical zones. First, as Netting (1986: 67) states '[t]he more we learn about indigenous agricultural methods, the more clearly it appears that food producers characteristically practice varieties of both shifting and intensive cultivation simultaneously'. Second, though there are differences between the soils of the tropics and those of more temperate zones, it is a mistake to consider tropical soils as necessarily nutrient-poor or lateritic (cf. McNeil 1964), and thereby requiring shifting cultivation. Recent studies of tropical soils (e.g. Falesi 1974; Wambeke 1978) demonstrate their local and regional variability and show that their relative productivity depends on a complex of biotic and abiotic factors (Sanchez 1976; Roosevelt 1980; Moran 1981; Kellman et al. 1982; Christanty 1986). The

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climate and soils of temperate zones are no less variable than those of the tropics, and it is quite likely that shifting agriculture was also a part of the early, temperate agricultural repertoire (Gregg 1988: 30–5).

This introduction to ethnopedology consists of two sections. The first is an overview of folk classifications of soils, in which ten case studies are considered. The second is a case study from Africa that allows us to examine the importance of soils as a factor in agricultural settlement patterns.

Folk classifications of soils in the tropics

To better understand the question of how indigenous food producers have coped with the various constraints of tropical soils, anthropologists and geographers have increasingly turned their focus to folk classifications of the tropical environment. A basic assumption is that the words used to describe environmental phenomena (such as soils) tag the processes by which humans cognitively deal with their environment (Lenneberg 1967: 334). Once anthropologists began to document the classificatory knowledge shared by mature speakers of a language, they quickly demonstrated that most folk societies have well-developed taxonomies of phenomena such as plants and animals (Berlin et al. 1966; 1973; Brown 1984; Hunn 1976). Williams and Ortiz-Solorio (1981) have argued that a comparable, though less well-developed, taxonomic knowledge of soils exists in certain Mesoamerican societies.

Three important conclusions can be derived from Williams and Ortiz-Solorio's study of folk soil taxonomies. First, folk soil taxonomies are based largely on the surface appearance (or a two-dimensional view) of a soil, in contrast with most 'scientific' soil taxonomies which are built on a three-dimensional understanding of the soil surface and profile. This results in an incomplete correspondence between folk and technical soil taxa. In spite of this, the folk soil taxa reflect measurable discontinuities in soil characteristics such as colour, texture and consistence (Behrens 1989). Second, although Williams and Ortiz-Solorio argue that certain folk classifications of soils are hierarchically ordered taxonomies, the specific soil taxonomy used to argue their case consists of only *three* soil taxa, one of which is so rare that it is excluded from most of their analyses. The relative simplicity of this soil taxonomy contrasts sharply with the complex botanical and zoological taxonomies of comparable societies (Brown 1984). Third, information about soil fertility is not as important in these taxonomic systems as one might expect. Williams and Ortiz-Solorio (1981: 358) note that 'where intensive agriculture is practiced, soil fertility seems to be conceived as a technological/managerial, man-made attribute rather than as an inherent soil property'.

There have been a number of other ethnographic studies which have produced much longer lists of folk soil 'taxa' than the three in the 'taxonomy' examined by Williams and Ortiz-Solorio. However, many of these lists serve as cautionary tales for anyone interested in documenting folk soil taxonomies in the future. For example, Carter (1969) documented at least twenty-four descriptive categories for soils used by the Kekchi Maya of Guatemala. These descriptive categories are not exclusive of one another, and there is the possibility of 480 different combinations of these categories, or 'types' of soil. In a re-examination of Carter's soil 'types' in a different Kekchi community, Wilk (1981: 138–41) found that many of Carter's soil 'types' are descriptive phrases (e.g. 'that is reddish soil') rather than discrete names. This is a problem common to many of the published lists of folk soil 'taxonomies'. There are a number of qualities that are commonly used to describe soils ('hot' or 'cold', 'hard' or 'soft', etc.), but these descriptions are not necessarily evidence of a taxonomy. Few studies of folk soil classifications have used formal elicitation frames to reveal taxonomic knowledge, and it is possible that some of the published soil 'types' represent distinctions made for the benefit of the interviewer, rather than taxonomic knowledge commonly employed by the informant (Wilk 1981: 138–9). These potential faults must be considered, but do not cripple the following investigation. To avoid any misunderstanding, we adopt the more general term 'classification', in place of the more hierarchically-ordered concept of 'taxonomy'.

A comparison of tropical folk soil classifications

Ten ethnographic studies are analysed in order to evaluate the conclusions of Williams and Ortiz-Solorio (1981) and to document the degree to which folk societies in the tropics recognize soil differences. The cases were selected to represent a range of climates, soils, and regions (Table 1). Mean annual precipitation ranges from approximately 500mm for the Tepetlaoztoc (Mexico) study to approximately 3,500mm for the Curripaco (Venezuela) and Tatuyo (Colombia) studies. In most of the cases the agriculture is subsistence-based. There is wide variety in the soil and climate requirements for the staple crops. The farming systems vary also, but a majority are at least partially dependent on shifting cultivation systems in which the land is used for only one to four years with fallow periods of ten or more years.

In most of the studies it is not clear how widely soil terms are recognized in a particular community and whether a truly taxonomic structure, or hierarchical relationship between taxa, is present. In many studies it is likely that an omniscient informant (Boster 1985) was the source of soils information. This is certainly true for the Williams and Ortiz-Solorio study (1981: 336), as they state '[the] perception and knowledge of soils as a pan-community, shared trait has disappeared (if it ever did exist), and suitable informants cannot be chosen at random from the population'. Even in situations where the classificatory terms for local soils is common knowledge, such as in the Tatuyo study, certain individuals are more secure in this knowledge than others.

The number of soil classes listed in Table 1 represent the number of soil types that appear to figure in agricultural decision-making in the specific study areas. The criteria listed are 'translations' of subjective criteria into those typically used in pedological studies; for example, a soil's organic matter content might be expressed in terms of 'greasiness' in a folk system. Most of the classifications have the possibility of being much more complex. Dove's (1985) excellent study of the Kantu' swidden system illustrates this possibility; cultivators have a total of seven subjective measures of soil differences – soil texture, hardness, moisture content, temperature, colour, taste, and smell – that could result in 128 combinations. Yet, since there is only one acceptable agricultural quality for each criterion, there are only two broad classes of soils: those that are acceptable for agriculture and those that are unacceptable. In at least several of the studies, classes of

Table 1 Examples of folk classifications of soils in the tropics.

Society#	*Location*	*Main crop*	*Farming system*	*Soil classes*	*Criteria**
Ifugao	Phillipines	rice, sweet potatoes	irrigated terraces & swidden with 6–9 year fallow	11	CIPTV
Tsembaga	Papua New Guinea	sweet potatoes, taro, yams	swidden with 15–25 year fallow	2(?)	C
Raiapu Enga	Papua New Guinea	sweet potatoes, taro, yams	intensive agric. & swidden with bush fallow	3	COm
Kofyar (Jos)	Nigeria	sorghum & millet	intensive agric. & swidden with 15–20 year fallow	7	CMcT
Kantu'	Kalimantan, Indonesia	sorghum & millet	swidden with 2-more than 10 year fallow	2 (or 128)	ACMcT
Tepetlaoztoc	Mexico	corn	intensive use, no fallow noted	3	CPmT
Yucatec	Mexico	corn	milpa with 11 year fallow	4	CIT
Machiguenga	Peru	cassava & corn	swidden with long fallow	5	ACIT
Curripaco	Venezuela	cassava	swidden with long fallow	2	C
Tatuyo	Colombia	cassava	swidden with 10–15 year fallow	6	CITV

References: Ifugao (Conklin 1957; 1980); Tsembaga (Rappaport 1968); Raiapu Enga (Waddell 1972); Kofyar – Jos (Netting 1968); Kantu' (Dove 1985); Tepetlaoztoc (Williams and Ortiz-Solorio 1981); Yucatec (Ewell and Ewell-Sands 1987); Machiguenga (Johnson 1982, 1983); Curripaco (Hill and Moran 1983); Tatuyo (Wilshusen, unpublished data).

* Soil criteria: A = Acidity, C = Soil colour, I = Soil inclusions (e.g. gravel), Mc = Moisture content, Om = Organic matter, P = porosity, Pm = Parent material, T = Soil texture, V = Viscidity (i.e. stickiness, or a rough measure of the amount of clay).

soils relating to tasks other than agriculture, such as for house or ceramic construction, were omitted from the listing.

Even a cursory look at Table 1 shows that the soil classifications are very simple. The Ifugao have the most complex 'soil' classification; however, these 'soils' are not naturally-occurring pedogenic units, but instead are terrace sediments sluiced into place by the Ifugao. The Ifugao classification has eleven categories, and the other nine classifications range from two to seven soil classes. In most classifications no more than one or two soils are considered excellent or good for agriculture, with one or two considered adequate or marginal. For example, in Wilshusen's sampling of soils from fourteen Tatuyo gardens and the area surrounding these gardens, one soil class, *jita hwaro*, represents almost two-thirds of all the samples, and many of the other soil classes represent soils found in association with this modal class (Table 2). In the case of the Tatuyo, it does not appear that the small numbers of soil classes result from the loss of ethnoagronomic knowledge with the increasing acculturation, because there are approximately 100 varieties of cassava still recognized in the same community (Dufour 1988: 257). The low

Table 2 Tatuyo soil classes.

Tatuyo soil class	*# of samples*	*Texture (mode)*	*Colour (mode)*	*Remarks*
jita hwaro	39	sandy clay loam	yellow brown to dark yellow brown	major soil type in study area
jita nirije	4	sandy clay loam	dark yellow brown	distinguished by high Om %
jita witaro	3	clay	yellow brown	high clay %
jita pijiyepa	7	sandy clay	yellow brown	distinguished by gravel inclusions
jita paayepa	4	sandy loam	light grey	sandy soil
jita tataboro	4	sandy loam	white to light grey	savanna, no good for agriculture

number of soil classes is not to be explained by a lack of variability in the soils of the area, for just the opposite is the case.

Several anthropologists whose work is represented in Table 1 have offered explanations of the apparent simplicity of these classifications. Johnson (1982) has argued that the five soil classes of the Machiguenga represent more than simple descriptions of soils; they delineate subtle differences in ease of cultivation, overall productivity, and land use. Thus, it may be incorrect in some cases to dismiss five soil classes as a 'simple' classification. From an almost opposite tack, Moran (1983) proposes that the relative simplicity of many Amazonian soil classifications arises from a commitment to certain agricultural crops and strategies, resulting in considerable mobility, which prevents the development of site-specific agronomic knowledge. Following Williams and Solorio-Ortiz (1981), the simplicity of the soil classifications may be explained by the fact that most soil systems are based on surface appearances, rather than a three-dimensional look at the soil. Although soil classifications miss much of the subsurface variability, this need not suggest that the classifiers are unaware of other indicators of variability of their environment (e.g. Posey 1984; Beckerman 1987: 74–5). Most of the societies examined here have classifications of land forms or terrain, land-use groups based on vegetation patterns, and other environmental knowledge.

The lack of soil classes simply may result from the fact that people rarely talk about this knowledge. In the case of the Tatuyo, soils are primarily discussed when a new garden is about to be cut (i.e. once a year), or when an anthropologist tries to elicit names for common soils. In contrast, there are daily uses of the complex taxonomic knowledge of plants and animals.

The fact that the Ifugao classification is the most complex among the studies considered here reinforces the idea that agricultural intensification *may* contribute to a corresponding increase in the complexity of classifications. The Ifugao create artificial terrace sediments and a detailed classification of these sediments, instead of attempting to refine their classifications of existing soils to emphasize crop productivity. In this particular example, it should be noted that the productivity of rice-paddy agriculture sometimes has as much to do with the quality of water regulation and the input of labour at critical times as it does with the quality of the sediment in which the rice is grown (cf. Geertz 1963: 32–6).

In several of the studies discussed here (e.g. Moran 1983: 126; Dove 1985: 75) soils are not the primary consideration in settlement strategy. This does not mean that indigenous food producers are unaware of or unable to talk about soils, but that for them soils play a smaller part in agronomic 'success' than neotechnic farmers might think.

To summarize: most folk classifications of soils appear to be best at predicting the ease with which ground can be cultivated with moderate, or good, returns; the classifications appear to encode only basic information about soil fertility and potential crop productivity. With these understandings, it is possible to examine the part that soils placed in the settlement of an agricultural area.

Exploring new soils: the case of the Nigerian Kofyar

Over the past four decades the Kofyar of Nigeria have been migrating from a homeland in the Jos Plateau to an agricultural frontier in the Benue Valley to the south and west. The Jos Plateau's hills and adjacent plains have traditionally provided a refuge from slaving and raiding threats. By the 1960s Kofyar population densities had exceeded 300 per sq km in places on and around the Jos Plateau (Stone et al. 1984). Agriculture was highly intensive, with annual cultivation of millet, sorghum, and cowpeas in manured plots surrounding each residential compound. Field surfaces were cleared of rocks and hoed into waffle ridges, to control runoff and facilitate infiltration, and steep hillslopes were extensively terraced.

The suppression of raiding and the higher ratio of productive land to population in the Benue Valley are probably the main reasons for the initiation of the Kofyar migration. The first compounds were established approximately 30 km south of the traditional Kofyar homeland in the early 1950s. The low population density allowed highly productive slash-and-burn farming, and Hausa traders provided a ready market for rice and yams produced by the frontier farms. Moving from a familiar area, where they had developed various means of classifying soils, to a new landscape which presented different soils and favoured different agricultural strategies, the Kofyar offer a case in which we can track the significance of soils in settlement strategy.

Geology and soils: the homeland

The Kofyar homeland is in the rugged hills of the south-eastern corner of the Jos Plateau. This plateau is an erosional remnant of the Gondwanaland surface. It is composed of Precambrian to Cambrian rocks (mostly granites) known as the Basement Complex, with intrusive Jurassic granites in places (Stone 1988). Volcanism in the Tertiary left a scattering of cinder cones and basalt flows on and around the Plateau. The soils in the hills are typically thin and hillsides are terraced to increase the depth of the agricultural profile. The densest Kofyar population was, prior to migration, at the foot of the plateau where soils are thickest (Stone et al. 1984). These soils are either sandy soils derived from stream deposits or clayey soils derived from Tertiary lava flows.

The Kofyar have no consensus on either the naming of soils or the appropriate criteria for soil classification. However, there are several generally accepted names for major soil classes: 1) *es*, a sandy or sandy loam soil, occurring mainly in alluvial deposits around the escarpment base; 2) *jing*, reddish clayey soils derived from weathered Tertiary basalt; 3) *baan*, a sandy loam with a reddish brown hue; and 4) *garas*, hard ground with gravel inclusions, occurring in places on the plateau and on the plains beyond the *es* and *jing*. Excessively rocky soil is considered *baap*, or unfarmable wasteland.

Land-use patterns are shaped in part by the variability of soils. Farming is especially concentrated in the sandy *es* at the foot of the escarpment base. In places the soil has been leached of humus and nutrients and has been invaded by Imperata grass; this 'white earth' is termed *yilpiya*. *Jing* soils are known to be very fertile, but tend to be avoided because they are arduous to work. Some abandoned compounds can be found on *jing* soils, reflecting times when population was pushed beyond the *es* soils. As might be expected, *baan* soils are intermediate between *es* and *jing* in terms of preference. *Garas* is a poorer medium for cultivation of staple crops, although the predominantly woman's crop of Bambara groundnuts (*Voandzeia subterranea*) thrives in it.

Geology and soils: the frontier

The frontier area to the south and west of the traditional Kofyar homeland shares some of the geology found in the homeland area. The Benue piedmont is to the south of the Jos Plateau and has soils derived from the same Basement Complex granites found in the homeland. The Benue Valley is a wide trough filled with Cretaceous sedimentary deposits. The lithology is dominated by sandstones and shales (Offodile 1976: 20–30), in which sandy and clayey soils are developed (Hill 1979; Stone 1988: 108–12).

There is no consensus among the Kofyar on the classification of frontier soils. The sandstone-derived soils are agreed to resemble the homeland *es*, although that term is rarely used on the frontier. The clay soils of the frontier are termed *dangka*, meaning heavy clay. These soils have no counterpart in the homeland. An important agronomic difference between the sandy and clayey soils is that whereas the sandy soils are well drained, the clayey soils often develop drainage problems after several years of cultivation.

The intensive agricultural practices of the homeland were initially absent on the frontier. Agriculture has been intensified as population has increased in the frontier, but this has taken forms other than manipulation of the soils (Stone et al. 1990). Soil properties do not dictate farm location or farming techniques, which makes the lack of a well-developed soil taxonomy more understandable. In the 1950s and 1960s, when Kofyar migrants had their pick of farm locations, the main criterion for site selection appears to have been proximity to water. All the earliest settlements were on sandy soils, but this is because the sandy soils occur to the north of the clayey soils and were reached first by the Kofyar migrants (Stone 1988). As options diminished in the 1970s and 1980s, farmers increasingly moved into the *dangka*. When it is pointed out that the clayey soils may be poorly drained, farmers respond that the large farm size available on the clay areas is a higher priority. Agricultural practices do not differ substantially on clayey and sandy soils.

Where agricultural practices do diverge according to soil type it is the result of the farmer's response to declining productivity, whether caused by deteriorating drainage or soil fertility. Stone's (1988) analysis of the settlement histories of Kofyar frontier farmers shows a strong tendency towards abandonment of farms on clayey soils, as opposed to continued residence and agricultural intensification on the sandy soils.

Conclusions

This brief exploration of ethnopedology has not emphasized the multifaceted nature of ethnoagronomic knowledge; instead we have focused on the soil classification systems of traditional agriculturalists and the relation between soils and settlement strategies. Although indigenous cultivators in the tropics have a great deal of environmental information at their command, it is clear that the information encoded in soil classifications is relatively simple. Both the folk soil classifications and the settlement strategies related to soil distribution appear to be more designed to cope with constraints than to maximize productivity.

Variability in soils is only one part of the total equation for a successful harvest. Agricultural success in traditional agricultural systems is constrained by many other variables, including the planting density, vigour, and relative productivity of particular cultivars; the quantity and quality of the agricultural labour investment (Boserup 1965); and the vagaries of events beyond human control (Malinowski 1935; Dove 1985). A soil classification system that has no more than three or four categories of soil quality (e.g. good, mediocre, and lousy) may be quite sufficient.

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Abstract

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An ethnoarchaeological perspective on soils

As archaeologists become increasingly sophisticated in their use of soils in understanding settlement patterns, it is necessary to consider what prehistoric food producers might have known about the soils of their landscape and how this could have influenced their land use strategies. A review of ethnopedological studies demonstrates that non-Western soil classifications tend to be less developed than comparable folk botanical or zoological classifications and that they usually consist of no more than four or five soil categories. An analysis of historic settlement patterns of the Nigerian Kofyar shows that soil variability may not be the primary determinant in the location of early agricultural settlements. Archaeologists may wish to follow the lead of traditional agriculturalists and understand the full variety of locational constraints on agricultural settlements, before using subtle differences in the distribution of soils as the primary explanation of settlement variability.